

Overcoming Barriers to Entry in an Established Industry:

TESLA MOTORS

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The automobile industry's high costs of entry, economies of scale, and network effects from distribution, fueling, and service lead many to conclude that new entrants have no chance. Tesla Motors has overcome many barriers to pioneer electric cars. Starting with partnerships and a minimum viable product, Tesla is working to innovate and scale up. Tesla now produces a top-selling luxury car and has a market capitalization twice that of Fiat Chrysler and half that of General Motors or Ford. Tesla has shown that a startup can enter and disrupt the status quo in one of the most established industries. (Keywords: Innovation, Barriers to Entry, Electric Cars, Entrepreneurship, Silicon Valley, Case Study, Environmental Protection, Environmental Policy)

Are certain industries so difficult to enter that they are destined for lower levels of entrepreneurship and innovation? If one looks at Porter's five forces analysis, industries like the automobile industry seem especially immune to the threat of new entry and upstart competitors. Numerous factors that Porter identifies, including economies of scale, learning curves, access to distribution channels, patents, unrecoverable up-front R&D expenditures, and other capital requirements can serve as barriers to entry, and all of them seem to be present in the auto industry. Thirty-five years ago, Porter wrote, "In the auto industry economies of scale increased enormously with post-World War II automation and vertical integration—virtually stopping successful new entry."¹ At that time, General Motors, Ford, Chrysler (plus AMC/Jeep), Honda, Nissan, and Toyota constituted six of the seven top-selling car companies in the United States, and the same is true today.²

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The high costs of entry in the auto market have led many to speculate that even if a better product existed, incumbents could successfully keep it off the market. A prime example is the electric car, which has long been a dream of those seeking to reduce auto emissions but a product that many considered as too difficult to introduce. The movie *Who Killed the Electric Car?* is perhaps the opposite of investigative journalism at its finest, but it advances a popular sentiment. It suggests that electric cars benefit

everyone by reducing emissions and improving air quality and are “a winner for consumers.” However, it says that electric cars “are a threat to the profitability of the conventional gas-powered auto industry” so “economics and corporate power stopped California’s electric car program in its tracks.”³ Compared to gas-powered vehicles, electric cars lack a refueling infrastructure and a distribution and service network. To frame the problems using the language of potential market failure, introducing an electric vehicle means facing network externalities associated with electric cars (such as the need for new charging stations compared with the fueling stations that gas-powered vehicles already have) and high barriers to entry (such as the high fixed costs of introducing new technology and building the production capacity that incumbents already have).

Although innovation in an industry does not necessarily require new entrants (incumbents will and frequently do innovate whenever they can),⁴ new entrants often view industries in a totally different way and embrace such change. Yet entering certain industries is more difficult and that has the potential to affect outcomes in an industry. In 2011, one observer stated, “The higher the capital requirements, the higher the barriers to entry...When there are high barriers to entry, then you don’t see new entrants, and you don’t see innovation. It’s really that new entrants are what drives innovation.” This observer was Silicon Valley entrepreneur Elon Musk, Tesla’s initial investor, co-founder, and CEO, who viewed all of the barriers in the auto industry as ones that could be overcome.⁵ Electric car company Tesla, founded in July 2003, produced its first car, a \$110,000 Roadster, from 2008 through 2012; it has produced its second car, a \$70,000 base price four door Model S since 2012; it is planning a similarly priced crossover for the second half of 2015; and it anticipates producing a \$35,000 sedan for 2017. As Musk explains, “Our goal when we created Tesla a decade ago was the same as it is today: to drive the world’s transition to electric mobility by bringing a full range of increasingly affordable electric cars to market.”⁶

Tesla’s long-run success, with or without current preferential tax treatment, is to be determined. Nevertheless, within twelve years, Tesla has created one of the top-selling full-sized luxury cars in the United States and has built a company with a market capitalization about twice that of Fiat Chrysler and half of Ford or General Motors. (The 2014 year-end market capitalization for Tesla, Fiat Chrysler, Ford, and General Motors were \$28 billion, \$12 billion, \$60 billion, and \$56 billion;

and average market capitalizations over the course of the year were \$28 billion, \$10 billion, \$62 billion, and \$55 billion, respectively.) Tesla's Model S has won multiple car of the year awards and earned an all-time top rating from *Consumer Reports*.

In this article, we document some of the ways that Elon Musk and Tesla have overcome barriers to enter the automobile industry and help pioneer electric cars. We gather information mostly from taped interviews, corporate documents, industrial and media reports, and personal interviews with people in Silicon Valley and the electric car industry including Tesla. Between the three authors, we have spoken with various people at Tesla including Musk, but we do not have any close connection with them or financial stake in Tesla.⁷ We would be just as happy to see another company succeed, but we should admit we are impressed with Musk and Tesla's achievements and think others can learn from them.

In an industry with many challenges, including large fixed costs, network effects, and incumbents that might prefer to preserve the status quo, Tesla is showing that a Silicon Valley startup can overcome many seemingly insurmountable economic problems. Tesla also has relied heavily on alliances, allowing Tesla to leverage expertise and infrastructure of other firms rather than having to constantly reinvent the wheel.⁸ It began by partnering with Lotus for its first minimum viable product and has since built its own production capacity by transforming a 5.5 million square foot former General Motors and Toyota plant in Fremont, California, into its own high-technology production facility. Tesla is now attempting to address network effects in the electric car industry by building distribution, service, and charging centers and encouraging other firms to enter the industry.

Conspiracy theories expressed in *Who Killed the Electric Car?* not withstanding, startups care little about preserving the status quo and often want to dramatically change an industry. Musk noticed that companies like General Motors were not developing electric cars as effectively as they could and that led him to enter that space. According to Musk, "the single largest macro problem that humanity faces this century is solving the sustainable energy problem—that is, the sustainable production and consumption of energy," but rather than waiting for a solution, Musk states, "the only way I could think to address that was with innovation."⁹ Although electric cars do not necessarily reduce the consumption of fossil fuels or emissions overall, they have the potential to, especially if lower emission power sources like nuclear become more widespread. The "well to wheels" emissions equivalents for electrics vary based on how electricity is generated and when one draws from a grid, and electric car battery storage also has the potential to draw from the grid at non-peak hours or more effectively utilize intermittent energy sources such as wind or solar.¹⁰

Musk states that it is tempting to reason by analogy and infer that the market will be similar to how it exists now. However, entrepreneurs are capable of bringing products to market that others have not envisioned. As another Silicon Valley entrepreneur, Steve Blank, has stated, "Capitalism is an evolutionary process where new industries and new companies continually emerge to knock out the old." Following Schumpeter, Blank explains how "entry by entrepreneurs

was the disruptive force that sustained economic growth even as it destroyed the value of established companies.”¹¹ Despite the fact that many thought that electric cars could never compete with gas-powered vehicles, Tesla has shown that Silicon Valley-style thinking can help overcome entry barriers even in the most established of industries.

Perspectives on Entrepreneurship in Silicon Valley

Bahrami and Evans write, “Silicon Valley is intensively competitive, continuously innovative, and lives with uncertainties about which there can be limited or no prior knowledge.”¹² Although parts of the country and world are important sources of innovation, we think that Silicon Valley is the “capital of ‘technology’ in general” for a reason. As Musk states, “Silicon Valley has evolved a critical mass of engineers and venture capitalists and all the support structure—the law firms, the real estate, all that—that are all actually geared toward being accepting of startups.” Silicon Valley has many people and many approaches, but it has something of a business culture that focuses on innovation. When asked about the future of self-driving cars, Elon Musk states, “Tesla’s a Silicon Valley company. If we’re not the leader, shame on us.”

Appendix 1 summarizes Musk’s perspectives on entrepreneurship and how they relate to some of the business writings on Silicon Valley. Many who write about Silicon Valley point out that markets are more open-ended and dynamic than the older structure-conduct-performance analysis that took snapshots of industry market share and assumed they would persist. Having a high market share in a market about to be displaced is not that valuable. To Bahrami and Evans, the market is a Darwinian process where firms need to constantly innovate and prune excess to survive.¹³ Musk’s former colleague Peter Thiel argues that entrepreneurs should avoid following trends and says that the most important entrepreneurs create new markets. To do this, Musk maintains that one has to think about how matters “could be” rather than “how they are.” Musk advocates reasoning from first principles to think about what could exist, as opposed to reasoning from analogy to make inferences based on existing products. Musk explains:

“The normal way we conduct our lives is we reason by analogy. We are doing this because it’s like something else that was done, or it’s like what other people are doing....Somebody could say, in fact people do, that battery packs are really expensive and that’s just the way they always will be because that’s the way they were in the past. But, no, that’s pretty dumb. Because if you applied that reasoning to anything new then you wouldn’t be able to get to that new thing. Like you can’t say ‘Nobody wants a car because horses are great and we are used to them and they can eat grass and there is lots of grass all over the place and there is no gasoline that people can buy so people are never going to get cars.’ And people did say that.”

He states: “I think maybe some of the larger car companies are just trapped in their own history.”

Although Musk believes in theorizing about how things might be, Musk is a strong believer in coming up with ideas that can be implemented. Musk says although he admires Nikola Tesla, “on balance I am a bigger fan of Edison than

Tesla, because Edison brought his products to market and made those inventions accessible to the world.” Musk recommends “being focused on something that you are confident will have high value to someone else.” He states, “A natural human tendency is wishful thinking. So a challenge for entrepreneurs is to say: ‘What is the difference between really believing in your ideals and sticking to them versus pursuing some unrealistic dream that doesn’t actually have merit?’ Can you tell the difference between those two things?...[At the end of the day, if] the economics don’t work, you’re not going to have an effect on the future.”

Key economic constraints that pretty much every entrepreneur faces, including Musk who was a multimillionaire at the time of Tesla’s founding, are limits in technology and initial capital. Although some entrepreneurs invest a large amount of money before releasing their first product, such an option is rare and risky. Instead of attempting to design the ultimate product for initial release, authors such as Blank and Dorf as well as Ries recommend starting with a minimum viable product and then expanding.¹⁴ Musk states, “The Tesla strategy has been the same from the beginning, which is to start out initially with a car that was expensive but low volume. It’s the only car that we could have really made and that was the Roadster sports car.” Musk explains how one must start small because of technology—“The reason for strategy is that in order to take any technology to mass market it takes time and you’ve got to go through major design iterations.”—and because of economics—“You also need economies of scale, so you’ve got to have much bigger factories. In order to afford those factories you have to raise a ton of money, and people will only give you money if you have shown some prior success. Otherwise, they [look at you with a doubting look and] they don’t believe you.” Their goal was to bring a quality but niche car to market that could be “profitable on low volume.”

As a firm is entering a market and updating its products, it must constantly seek feedback and figure out what customers really want. To Blank and Dorf and to Ries, entrepreneurs should constantly get out of the building to talk with customers and identify their needs. The goal is not to come up with a product that the entrepreneur personally prefers, but what consumers like most. As Musk states, “Put yourself in the shoes of the consumer and say why would you buy it as a consumer?” Don’t assume that you know what is best and seek out constructive feedback, even if negative. Musk recommends, “Constantly seek criticism. A well thought out critique of whatever you are doing is as valuable as gold. And you should seek that from everyone you can, but particularly your friends. Usually your friends know what’s wrong but they don’t want to tell you because they don’t want to hurt you....You at least want to listen very carefully to what they say and to everyone.” Musk states, “It’s very important to actively seek out and listen very carefully to negative feedback. And this is something people tend to avoid because it’s painful, but it’s a very common mistake....I don’t say ‘Tell me what you like,’ I say ‘Tell me what you don’t like.’”

Musk believes that the entrepreneur should start with the premise that he does not know everything and is often wrong, but he says, “your goal is to be less wrong” and that requires constant learning over time. A common practice in Silicon Valley is for firms to test out ideas or product features and potentially

improve them using iterative design. Cole, Finster, and Weston highlight the importance of using iteration to strive for continuous improvement and continuous innovation, concepts that come out of the theories of Total Quality Management.¹⁵ Blank and Dorf recommend treating product development scientifically and breaking ideas into hypotheses (often using a business model canvas), testing hypotheses, and learning along the way.¹⁶ Ries represents the process with a “build-measure-learn” loop where the entrepreneur is constantly building, learning, and updating rather than sticking to a 200-page business plan.¹⁷ When asked how Tesla came up with the design and whether they used a focus group or designed it to Musk’s preferred look, Musk states:

“No, it’s literally just a series of weekly iterations with the design team. Every Friday afternoon I meet with Franz and the design team and we go over every nuance of the car: every bumper, every curve, every little tiny piece of the car, what’s right, what’s wrong, and that has to be filtered against the engineering needs and the ergonomic needs and regulatory requirements. There’s a lot of constraints. You can’t just make a car any old shape you want and meet all of the regulatory requirements, the five star crash safety and all that. It just requires a lot of iterative activity and caring about every millimeter of the car. That’s what results in a good product.”

With many interdependent aspects of a car, it would be difficult to come up with a good final draft without iterations over time, and with each revision, the team has the ability to learn and improve. Musk states, “I think it’s very important to have a feedback loop, where you’re constantly thinking about what you’ve done and how you could be doing it better.”

Bahrami and Evans describe the importance of being agile or flexible, and although companies might have an ultimate goal in mind, they can be open to how to achieve goals or alter specifics along the way. Tesla is constantly testing the possibility of different ideas such as having easily replaceable batteries, no small feat for batteries weighing half a ton. However, consider the somewhat simpler choices that they have made. One of the co-founders Eberhard describes the process they used to pick the Roadster’s lead designer and key aesthetic features of the Roadster. First, they hired one designer to describe key features and solicit multiple sketches from other designers. Eberhard hung up the dozens of sketches from each designer and gave fifty people green and red sticky notes to place on features of the designs they liked or disliked. A high concentration of green sticky notes on one of the designs resulted in Tesla selecting Barney Hatt as the lead designer to submit his next proposal. Eberhard and Musk liked most of the design, but eventually convinced him to alter the nose, which they thought looked like a Pontiac Firebird. In another example, Musk described how his daughter complained how the Model S lacked a rear seat reading light calling it “the stupidest car in the world.” The car now has the light.

Can Common Practices from Silicon Valley Be Used in the Auto Industry?

Consider how Musk is implementing the ideas. Large incumbents have decades of experience, massive infrastructure, and large design teams that often

spend two to four years and billions of dollars to develop new models and update factories.¹⁸ Imagine doing all of that from scratch. Although he thought it was worth trying, even Musk considered the probability that Tesla could successfully get into the auto industry to be one in ten, and others were more skeptical calling it the next Webvan.¹⁹ As Musk described: “There were certainly many hiccups. That’s an understatement. More like choking to death and barely surviving. So it was difficult. Never having been in the auto business, it was impossible to predict all of the issues we would encounter ahead of time. So we knew it would be hard, but we didn’t know it was going to be as hard as it was.” Yet Musk believed in learning while doing and starting “doing something that requires low capital...and with the success of that, then take the capital and try plowing it into your second company. That’s what I did basically.” Musk parlayed his experiences and capital from co-founding firms like PayPal into running an auto company, and he also parlayed experience and capital from his first small-scale car to larger-scale ones.

Tesla states that its culture is to “move fast” and “constantly innovate,” and it has created a “direct feedback loop” that “accelerates development.” Consider the time and investment Tesla spent bringing its first two products to market compared with its more established rivals. Each company uses different accounting methods to assign overhead, costs of shared components, and other costs such as building or refitting often-massive factories, so precise comparisons between firms about the cost of developing new cars are not possible. Nevertheless, some apples to oranges comparisons are revealing. The cost of developing the Tesla Roadster and Model S were around \$140 million and \$650 million whereas General Motors spent \$1 billion developing its first electric, the EV1, and \$1.2 billion developing the Chevy Volt, and Nissan has spent \$5.6 billion developing its relatively low-performance electric cars.²⁰

Quickly bringing their first cars to market helped Tesla show to consumers and investors that relatively high-performance electric cars were possible. As one Toyota executive stated, “This is a gut check for us.... We said to ourselves, ‘Look at how Tesla is getting to market so quickly. They seem to be inventive and cutting-edge. Are we too engrossed in our own culture?’” They followed a different approach rather than spending years in the drawing room, the Toyota executive stated, “Tesla is a lot different. They get the standards and specifications set, and then change it on the fly. They spend more time in the validation phase. We spend more time in up-front planning.” In 2009, Robert Lutz from General Motors stated, “All the geniuses here at General Motors kept saying lithium-ion technology is 10 years away, and Toyota agreed with us—and boom, along comes Tesla. So I said, ‘How come some tiny little California startup, run by guys who know nothing about the car business, can do this, and we can’t?’ That was the crowbar that helped break up the log jam.” Four years later, an executive from General Motors stated, “[CEO Akerson] thinks Tesla could be a big disrupter if we’re not careful....History is littered with big companies that ignored innovation that was coming their way because you didn’t know where you could be disrupted.” Ford Executive Chairman Bill Ford also stated about Tesla, “It’s really hard to start a company, particularly in the auto business, and be successful.... My hat’s off to them.”²¹

How Tesla Reduced Costs of Entry and Learning Curves: Forming Partnerships, Leveraging Other Firms' Capital, and Quickly Bringing Products to Market

Consider some of Tesla's specific steps. Even though Tesla eventually hopes to produce mass-market electric cars, spending years in the design room and the preproduction phase for a large scale could have ended in a disaster in many ways. Instead, Tesla started small with what can be considered a minimum viable product with their low-volume roadster.²² Without a pipeline of products about to be released, a huge amount of capital, and the luxury of spending as much as many of their competitors, timing was important. In 2006, Tesla co-founder Martin Eberhard stated their goal was to bring their first car "to the market quickly and efficiently" and they did so through partnerships with existing firms.

In 2004, Tesla approached Lotus to discuss a partnership and over the next couple of years formed a relationship where Lotus would help with design, engineering, and technology and be the contract assembler of Tesla's first vehicle. Eberhard stated, "Much as I love cars, I am the first to admit that neither I, my co-founder, Marc Tarpenning, nor our original investor (and chairman of our board), Elon Musk, is an automotive engineer." Lotus Engineering assisted with analysis and supply chain and starting with Lotus Elise licensed technology, and Tesla's U.K.-based engineering team designed the chassis. Tesla was able to "save time and money" by heavily relying on Lotus for issues related to structure and safety. Having shared safety components let Tesla buy windshields, airbags, and automatic braking systems from the same suppliers. Such modular relationships let Tesla incorporate relatively complicated components without having to design them anew. Various authors have talked about how modular relationships common in the technology industry let firms get into and out of new areas with relative ease, and partnerships let firms leverage the knowledge and infrastructure of existing firms.²³

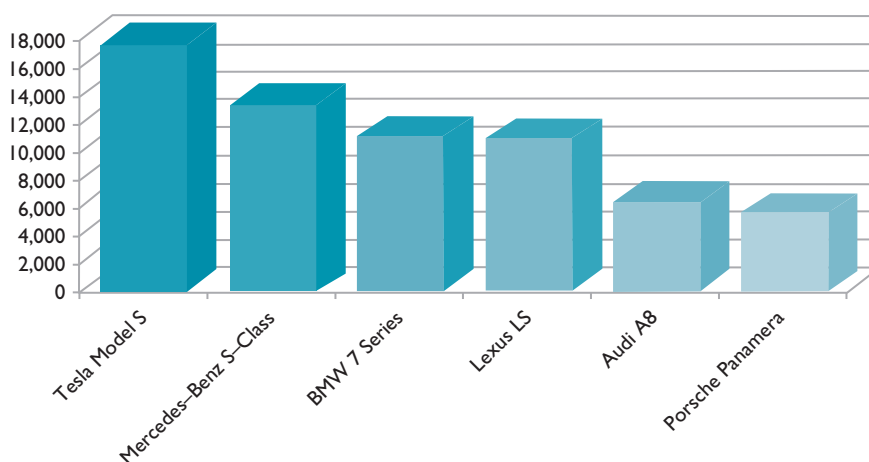
Lotus assembled the car and about 6 percent of Roadster parts overlapped with those of its British relative. *Automobile Magazine* likely underestimated the Roadster's novelty, describing the cars as: "Lotus Elises [converted] to run on batteries....everything else about the \$100,000 Roadster felt like the \$50,000 Lotus Elise on which it was based." Yet the product turned out well and had a range and performance competitive with many high-end gas vehicles. The Roadster had a 245-mile range, 0 to 60 miles per hour acceleration of 3.6 seconds, and a top speed of 130 miles per hour. Eberhard stated, "Just about three years from the day Marc and I started Tesla, we saw our first real Roadster from the assembly line." Development of the Roadster cost more and took longer than they anticipated and Musk now states he wishes Tesla had done more in house. However, Tesla produced 2,500 Roadsters in its four years of production and that car enabled Tesla to move toward its next stage. Musk states it was "the beachhead of the technology. It's the introductory product [that] allows us to refine the technology and make [it] more affordable over time."²⁴

Tesla was then able to plan for the larger-scale production Model S and got there through partnerships with Daimler, Panasonic, and Toyota. In 2009, Daimler

invested \$50 million and subsequently formed an agreement for Tesla to supply drivetrains to Daimler's Smart and Mercedes, and in 2010, Panasonic invested \$30 million and created an agreement to develop batteries with Tesla. Some of Tesla's most important transactions were with Toyota, which in 2010 invested \$50 million for shares in Tesla's IPO and sold Tesla its New United Motor Manufacturing, Inc. (NUMMI) plant in Fremont, California, for \$42 million.

Tesla benefited from the purchase by having a space ready to retool, and Toyota benefited by not having to write the space off at a total loss. Recycling the factory²⁵ freed up by General Motors and Toyota thus gave Tesla space to produce the Model S and subsequent higher-volume vehicles. Introduced in June 2012, Tesla produced 35,000 Model S cars in 2014 and currently produces 1,000 cars per week with capacity to expand. Ward's Auto classifies the Model S (\$70,000-\$105,000) as a middle luxury car that competes with the Audi A6 (\$46,000-\$60,000), BMW 5 Series (\$50,000-\$71,000), Cadillac XTS \$45,000-\$70,000), Lexus GS (\$47,000-\$57,000), and Mercedes E-Class (\$52,000-\$103,000) whereas others classify the Model S in the European Commission F-segment (full-size luxury cars), competing with similarly priced Audi A8 (\$77,000-\$138,000), BMW 7 Series (\$74,000-\$141,000), Lexus LS (\$73,000-\$88,000), Mercedes S-Class (\$93,000-\$139,000), and Porsche Panamera (\$78,000-\$200,000). In the United States, the competitors in middle luxury segment sell between 20,000 and 70,000 units per year as opposed to the roughly 20,000 for Tesla. Among those in the full size luxury segment, Tesla has outsold all but the Mercedes S-Class for the past couple years (Figure 1). Such sales figures would not have been possible had Tesla not started relatively small with the Roadster and then scaled up.

FIGURE 1. Full-Size Luxury Sedan Sales in the United States, 2013



Source: Data are from Mark Rogowsky, "Tesla Sales Blow Past Competitors, but with Success Comes Scrutiny," *Forbes*, January 16, 2014.

Overcoming Network Externalities: Expanding Markets with Charging Stations, Distribution, and Service

Tesla used knowledge from Silicon Valley to reduce potential barriers to entry, and Tesla is also using knowledge from Silicon Valley thinking to deal with network effects, or network externalities, in the auto industry. A network effect is present when the value of a good depends on how many other consumers use the good. For example, being the only person in the world with a telephone or an Internet server would be of little value. From payment processing to software systems and social media, the value of many networked products depends on the number of users. More traditional products like cars can also have network effects when the number of users and service centers in an area matter.²⁶ Although some forms of network externalities will forever be present, firms can overcome and internalize network externalities by owning and subsidizing parts of a network to increase the number of users.

Consider, for example, the strategy of one of Musk's first co-founded companies, PayPal, which gave new users and their referral a \$10 bonus for each person who signed up. This promotion was costly, but it helped increase the number of users from 1,000 in October 1999 to 1 million in April 2000 to 40 million when eBay bought the company for \$1.5 billion in 2002. Other tech firms also subsidize different parts of a network to expand the number of users and increase the value of the product line. The "hardware-software paradigm" theory in economics describes how a hardware (or software) producer that receives spillover benefits from complementary software (or hardware) on its network may want to subsidize the production of the complementary product or vertically integrate to produce both.²⁷ Hardware producers, such as video game console manufacturer Sony, benefit from having more designers and customers on their network, so they often initially sell consoles below cost or subsidize early software production on the hardware's platform. With other arrangements, the subsidization can go in the opposite direction from software to hardware producers. Microsoft used to subsidize phone hardware producer Nokia to expand the amount of people with a Windows Phone. When capturing the benefits through such an arrangement is difficult, a third option for a producer is to become integrated and produce the hardware and software in a way that maximizes the value of both. Microsoft ended up choosing this route when it purchased Nokia's handset business in 2013, and Apple's phone business has been more vertically integrated all along. The optimal arrangement is not set in stone, but firms will seek to maximize the joint value of the hardware and software and that can include subsidizing parts of the ownership experience.

Tesla faces many of these dilemmas where cars can be considered the hardware and the technology, service, and charging considered the software. Musk even describes the car as "a very sophisticated computer on wheels," and states, "Tesla is a software company as much as it is a hardware company. A huge part of what Tesla is, is a Silicon Valley software company. We view this the same as updating your phone or your laptop." Like other Silicon Valley firms, Tesla has recognized the need to provide certain parts of the consumer experience at zero

cost to the consumer. Consider the growing charging network that Tesla is subsidizing. In 2013, *Consumer Reports* stated it did not give the Model S a perfect score because of potential issues with range and access to charging. Although Tesla owners can charge their cars using any 120-volt outlet, faster charging requires a 240-volt outlet like those used for home appliances, and even that takes hours. The more parking spaces that have 240-volt outlets and the more special charging stations there are, the more valuable Tesla cars become. One step that Tesla is taking is creating a Destination Charging program that subsidizes the installation of the \$750 Tesla Wall Connectors at participating hotels, resorts, and restaurants. Another important step that Tesla is taking is building a network of much faster charging stations that give Tesla owners electricity for 170 miles in a 30-minute charge. As of June 2015, Tesla has built 445 stations that charge at zero marginal cost to the user. Spending \$500,000 per station and not charging users anything is costly, but when viewing a charging network as equivalent to software in the “hardware-software paradigm,” one can understand why Tesla provides this complementary product at zero marginal cost. Tesla is also working with other potential charging-station companies and encouraging them to get into the space.

Another network effect that Tesla faces compared with established firms is a dealership, distribution, and service network. Tesla reports that one of the most common customer questions is about servicing the cars, and to address this concern, Tesla has built and is expanding Tesla owned-and-operated service centers. Tesla currently has fifty that operate with the following instructions from Musk: “What I’ve told the Tesla Service Division is their job is never to make a profit.” Here the firm is not acting altruistically, but working to increase Tesla’s profits overall by helping “quell fears about buying and maintaining an electric car and boost sales of the Model S sedan in the long run.”²⁸ By subsidizing one aspect of the ownership experience (and pricing it into the car), Tesla is working to maximize the value of hardware and software and to internalize those benefits.

One of Tesla’s most interesting moves to deal with network effects was to free all of its patents into the public domain. As of June 12, 2014, Tesla had hundreds of patents, yet they decided to make all of their patents open to the public to encourage other firms to enter the electric car space. As Musk states:

“Our true competition is not the small trickle of non-Tesla electric cars being produced, but rather the enormous flood of gasoline cars pouring out of the world’s factories every day. We believe that Tesla, other companies making electric cars, and the world would all benefit from a common, rapidly evolving technology platform. Technology leadership is not defined by patents, which history has repeatedly shown to be small protection indeed against a determined competitor, but rather by the ability of a company to attract and motivate the world’s most talented engineers. We believe that applying the open source philosophy to our patents will strengthen rather than diminish Tesla’s position in this regard.”²⁹

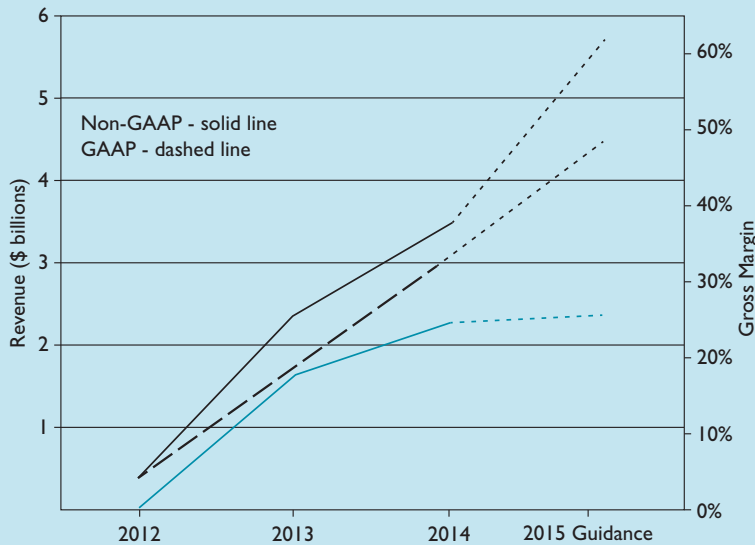
Tesla has benefited from the existing technology and manufacturing infrastructure of other car companies like Daimler, Lotus, and Toyota, and it sees the benefits of having more companies and engineers working on electric vehicles. Although Tesla has paid research and development costs that other firms will not, it may benefit from having more participants in the electric car network.

Tesla's approach flies in the face of theories that assume that businesses must rely on restrictions to protect their market position. Bahrami and Evans describe how Silicon Valley firms often rely on cross-pollination and adaptation of others' ideas and how much of their success can be attributed to the ecosystem that facilitates both competition and collaboration. The personal computer industry led by IBM, Microsoft, and Intel turned out much bigger because the large firms had many smaller firms contributing to their relatively open and modular product ecosystem.³⁰ Being a key player in a large product infrastructure can be better than having complete control over a proprietary but small one. More recently Google has gained 85 percent of the smartphone operating system by making much of its Android operating system open source and Microsoft is now making some of its products open source as well. Tesla seems to have gone a step further and is the largest company that we know of to make all of its intellectual property open source. By working to increase the size of the electric car market, Tesla has the potential to be in an important position in an increasingly large segment. The move may have other benefits too according to Musk: "Open sourcing the patents does have the advantage of making Tesla a more attractive place for the world's best engineers to work. And it builds goodwill, which I believe will be important."³¹

How Much Does Tesla's Success Depend on Government Subsidies?

Tesla has become a valuable company, but many critics argue that Tesla lives off government handouts rather than creating a value added product. Including \$280 million in tax breaks for consumers who purchased Tesla electric cars, \$520 million in Tesla's sale of regulatory credits, and \$1.3 billion in future tax incentives, mostly tax breaks, for building a battery factory in Nevada, the *Los Angeles Times* says that Tesla has received \$2.4 billion in subsidies. Musk, however, responds that "The \$1.3 billion that Nevada may wind up awarding Tesla is actually spread out over 20 years," and "In order for the factory to receive that economic incentive we actually have to have an economic output from that factory of about \$5 billion a year."³² Moreover, reductions in taxes are not the same as subsidies that require government to write checks to firms or individuals regardless of whether they are producing something of value. Sales of regulatory credits do impact Tesla's bottom line, but they have represented 7.7 percent of Tesla's revenue to date and Tesla expects that percentage to decrease as revenue increases. Without that extra source of revenue Tesla presently has a positive gross margin on each vehicle sold so their business model does not depend on it. Without weighing in on all of the specifics of the debate, we think that statements like "Tesla has not made one honest dollar" and "If Tesla would stop selling cars, we'd all save some money" are exaggerations.

continued on next page

FIGURE 2. Revenue and Gross Margin Expansion Since Model S Introduction Excluding Zero Emission Vehicle Credits

Source: Tesla Motors, "Fourth Quarter & Full Year 2014 Shareholder Letter," Palo Alto: Tesla Motors, 2015.

Conclusion

Tesla has shown that a Silicon Valley startup can enter one of the most established industries of all. Even though incumbent firms and their market shares are large, this new entrant is changing market structure and the value of existing firms. Rather than looking at the market and assuming that matters will always be that way, Musk saw an unmet need and used innovation to fulfill it. Starting with a minimum viable product, partnering with other firms, recycling capital, and subsidizing aspects of the electric vehicle network, Tesla has altered the landscape of the auto industry. Some firms, perhaps including Tesla, will eventually be displaced, but this Silicon Valley firm has helped pioneer a new way of powering cars. When asked how he figured he could be successful, Musk states, "Well, I didn't really think Tesla would be successful. I thought we would most likely fail. But I thought that we at least could address the false perception that people have that an electric car had to be ugly and slow and boring like a golf cart."

Up until 150 years ago, whale oil was the preferred fuel for lamps, but that changed with the invention of kerosene, a cheaper alternative that could power the masses.³³ Tesla is now offering an equivalent innovation that has the potential to reduce auto emissions, and let cars be powered by all types of energy, including

nuclear and solar. One cannot predict what products or companies will reign supreme in the future, but the entrepreneurial process allows for innovation and the replacing of old ways of doing things.

Even if Tesla is ultimately outcompeted, its high market capitalization has already benefited its investors and acted as a signal and attracted more investment into the electric car industry. When General Motors and Chrysler veered toward bankruptcy, the market was signaling that the incumbents were doing something wrong, and as the value of Tesla rose, the market is signaling that Tesla is doing something right. Currently, Audi, BMW, Mercedes, and Porsche have plans to compete in the electric car market. Even if they are more successful or take over the market, Tesla will have helped pave the way for a new technology in much the same way that now-defunct or purchased firms such as RCA, Zenith, Magnavox, Kodak, Polaroid, Commodore, Amiga, and Atari helped paved the way for modern stereos, television, photography, computers, and home entertainment. The entrepreneurial process constantly encourages firms to come up with better products and, in the process, disrupt existing market structures for the ultimate benefit of consumers.

APPENDIX

Approaches to Entrepreneurship in Silicon Valley and Ways Elon Musk and Tesla Use Them

What to do	Why	What not to do	What Musk and Tesla do
Envision markets dissimilar to existing ones	Markets can change and the role of the entrepreneur is to figure out new things. "Doing something different is what's truly good for society—and it's also what allows a business to profit by monopolizing a new market." ^a	Don't assume that the world always has to be this way or that current products, market shares, or market prices will be the same in the future.	Musk: "Don't just follow the trend." "I think it's important to reason from first principles rather than by analogy." Although he says "it's mentally easier to reason by analogy rather than from first principles" he says to "boil things down to the most fundamental truths and say okay what are we sure is true or sure as possible is true and then reason up from there."
Even if big, focus on economically achievable goals	Differentiate between ideas that simply sound good versus ones that actually can be implemented for the benefit of consumers. ^b	Theorizing without doing amounts to little more than daydreaming.	Musk: "If the economics don't work, you're not going to have an effect on the future."
Start small with a minimum viable product	Learn how to get into an industry with lower up front risks by starting small. ^c	Don't attempt to come out with the ultimate or final market product on the first try.	Musk: "The Tesla strategy has been the same from the beginning, which is to start out initially with a car

What to do	Why	What not to do	What Musk and Tesla do
	Many tech companies started with public beta versions of their products before moving onto more advanced or refined ones. ^d		that was expensive but low volume. It's the only car that we could have really made and that was the Roadster sports car. And then step two was a car that was sort of mid priced, mid volume car and that's the Model S and the Model X also fits into that category. And then our third generation car will be low price, high volume."
Seek feedback from others, even if negative	Constantly get out of the building and talk with potential customers to assess the potential need for the product. Ask others what can be improved. ^e	Don't ignore your potential consumers, don't assume you know all of the answers, and don't avoid constructive criticism, even if the criticism might hurt.	Musk: "It's very important to actively seek out and listen very carefully to negative feedback. And this is something people tend to avoid because it's painful, but it's a very common mistake." "I don't say 'Tell me what you like,' I say 'Tell me what you don't like.'"
Use iterated design and a feedback loop to update the product	Come up with an idea, design a product, test hypotheses, learn, update, and repeat. ^f	Don't assume you know the best imaginable product ahead of time or can get it right on your first try. Don't spend too much time at the drawing boards or be the mad genius working in a hidden lab for years.	Tesla uses what they call a direct feedback loop and Musk explains: "You've got to go through major design iterations to achieve [a mass market product] and that's why we are trying to get there as quickly as possible with three major iterations."
Be flexible based on consumer wants and knowledge gained along the way	Update plans, technology, partnerships, or approaches. Switch gears or alter directions when necessary. ^g	Don't assume the first plan was the right plan or continue to do things this way because you have always done them this way.	Musk: "I think that's the single best piece of advice: constantly think about how you could be doing things better and questioning yourself. ...Put yourself in the shoes of the consumer and say why would you buy it as a consumer?"
Work with others to leverage existing industry expertise or infrastructure	See what is available and work with it. If other firms have capabilities and are willing to build part of the product, work with them. If possible, form modular relationships with others that you can start, finish, expand or contract with relative ease. ^h	Don't do everything in house or build everything from scratch. Try to avoid large in house investments in capabilities that potential partners already have.	Tesla started by working with Lotus to help with technology, engineering, design, and assembly. Tesla formed partnerships with Panasonic, Toyota, and Daimler to develop batteries and supply drivetrains and purchased a former GM and Toyota plant in Fremont, California.

(continued)

What to do	Why	What not to do	What Musk and Tesla do
Enhance the total product experience, not just aspects of it	If the product involves complements like hardware and software, a producer may want to subsidize some aspects or become more vertically integrated and produce both. ⁱ	Don't ignore the availability and price of complements. Don't nickel and dime users on the price of complements at the expense of the consumer's overall product experience.	Tesla offers many free updates of software in shipped cars, subsidizes the production of zero priced charging stations, and has a network of service stations given instructions from Musk: "Their job is never to make a profit."
Enhance the value of the product network	The value of many products is affected by the number of users. If so, figure out how to expand the user base and that may include subsidizing the product's expansion. ^j	Don't be too proprietary or ignore the importance of having a big enough base and infrastructure for the product.	In addition to spending to expand dealerships and service centers, to encourage others to get into the electric vehicle space Tesla made its patents open source.
Figure out how to scale up	Products with relatively high fixed costs, learning curves, and network effects can have economies of scale over a relatively large range of production. Ideally a company will figure out how to make a product scalable without large growing pains and profitable at higher volumes. ^k	Don't ignore potential production costs at larger potential volumes. A handmade product may be designed not to scale, but otherwise don't ignore the potential path of starting small to growing big.	Musk: "You also need economies of scale, so you've got to have much bigger factories. In order to afford those factories you have to raise a ton money, and people will only give you money if you have shown some prior success. Otherwise they [look at you with a doubting look and] they don't believe you."
Constantly innovate to better serve customers	Markets are always evolving and one must continue to adopt. ^l	Even with past success, don't rest on your laurels and assume future business is guaranteed.	Musk: "I think it's very important to have a feedback loop, where you're constantly thinking about what you've done and how you could be doing it better."

a. Peter Thiel, *Zero to One* (New York, NY: Crown Business, 2014), p. 166.

b. *Ibid.*, p. 195.

c. Saras D. Sarasvathy and Nicholas Dew, "Without Judgment: An Empirically-Based Entrepreneurial Theory of the Firm," *The Review of Austrian Economics*, 26/3 (September 2013): 277-296.

d. Eric Ries, *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* (New York, NY: Random House Crown Business, 2011).

e. Steve Blank and Bob Dorf, *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company* (Pescadero, CA: K & S Ranch, 2012).

f. Ries, *op. cit.*, p. 71.

g. Homa Bahrami and Stuart Evans, *Super-Flexibility for Knowledge Enterprises: A Toolkit for Dynamic Adaptation* (New York, NY: Springer, 2010).

h. Michael G. Jacobides, John P. MacDuffie, and C. Jennifer Tae, "How Agency and Structure Shaped Value Stasis in the Automobile Industry," working paper, London Business School, 2012.

i. Michael Katz and Carl Shapiro, "Systems Competition and Network Effects," *Journal of Economic Perspectives*, 8/2 (Spring 1994): 93-115.

j. S.J. Liebowitz and Stephen Margolis, "Network Externalities: An Uncommon Tragedy," *Journal of Economic Perspectives*, 8/2 (Spring 1994): 133-150.

k. Thiel, *op. cit.*, pp. 54-55.

l. Bahrami and Evans, *op. cit.*, p. 6; Robert E. Cole, Mark P. Finster, and F.C. Weston, "From Continuous Improvement to Continuous Innovation, and Subsequent Discussions," *Quality Management Journal*, 8 (2001): 7-33.

Notes

1. Michael E. Porter, "How Competitive Forces Shape Strategy," *Harvard Business Review*, 57/2 (March/April 1979): 137-145.
2. Only Volkswagen fell out of the top seven in the U.S. market, being replaced by Hyundai, itself a nearly half-century-old industrial conglomerate that is the fourth largest auto producer in the world.
3. Chris Paine, *Who Killed the Electric Car? Press Kit*, Sony Pictures, 2006, p. 28. The film is controversial and detractors argue the film is little more than sensationalist fodder.
4. Jacobides, MacDuffie, and Tae describe how various factors including a relatively high degree of vertical integration often prevented automobile companies from innovating as quickly as firms in other industries such as high tech. They do describe, however, how incumbent firms have actively been selling off parts of their firms to deverticalize in an effort to move in the direction of technology firms. See Michael G. Jacobides, John P. MacDuffie, and C. Jennifer Tae, "How Agency and Structure Shaped Value Stasis in the Automobile Industry," working paper, London Business School, 2012.
5. Elon Musk, "Public Remarks" TechCrunch Disrupt Conference, San Francisco, CA, September 14, 2011.
6. Tesla Motors, "Tesla Motors Investor Presentation," Palo Alto, CA, Tesla Motors, January 2014.
7. YouTube channel *Every Elon Musk Video* has 150+ clips and most of the quotes in this article are from interviews listed there. Specific references for each quote are available upon request.
8. Car companies forming alliances to share technologies, learn manufacturing approaches, and leverage each others' infrastructure actually has a long history. In the early 1980s, Toyota wanted to expand manufacturing into the United States and needed to learn the lay of the land, and General Motors wanted to learn about Toyota's lean manufacturing techniques, so they formed a partnership to jointly produce cars in California. The partnership enabled General Motors to modernize many of its manufacturing techniques and it let Toyota experience some of the opportunities and challenges of producing cars in the United States. For more on this, see Andrew C. Inkpen, "Learning through Alliances: General Motors and NUMMI," *California Management Review*, 47/4 (Summer 2005): 114-136.
9. David Zenlea, "2013 Automobile of the Year: Tesla Model S," *Automobile Magazine*, November 1, 2012; L. Ulanoff (Director), "Musk: Tesla Is a Success, on Some Levels," *Mashable*, April 12, 2012.
10. For estimates of emissions based on location and timing of when electric cars charge, see Joshua Zivin, Matthew Kotchen, and Erin Mansur, "Spatial and Temporal Heterogeneity of Marginal Emissions: Implications for Electric Cars and Other Electricity-Shifting Policies," *Journal of Economic Behavior and Organization*, 107 (2014): 248-268; Don Anair and Amine Mahmassani, *State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings Across the United States* (Cambridge, MA: UCS Publications, 2012).
11. Steve Blank, "Strangling Innovation: Tesla vs. 'Rent Seekers,'" *Forbes*, June 24, 2013; Steve Blank, "ESADE Business School Commencement Speech," March 31, 2014.
12. Homa Bahrami and Stuart Evans, *Super-Flexibility for Knowledge Enterprises: A Toolkit for Dynamic Adaptation* (New York, NY: Springer, 2010), p. 3; Peter Thiel, *Zero to One* (New York, NY: Crown Business, 2014), p. 7.
13. See Bahrami and Evans (2010), op. cit., p. 6; Homa Bahrami and Stuart Evans, "Super-Flexibility for Real-Time Adaptation: Perspectives from Silicon Valley," *California Management Review*, 53/3 (Spring 2011): 21-39.
14. Steve Blank and Bob Dorf, *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company* (Pescadero, CA: K & S Ranch, 2012); Eric Ries, *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* (New York, NY: Random House Crown Business, 2011).
15. See Robert E. Cole, Mark P. Finster, and F.C. Weston, "From Continuous Improvement to Continuous Innovation, and Subsequent Discussions," *Quality Management Journal*, 8 (2001): 7-33.
16. Blank and Dorf (2012), op. cit.
17. Ries (2011), op. cit. See also the discussion of effectual learning by Saras D. Sarasvathy and Nicholas Dew, "Without Judgment: An Empirically-Based Entrepreneurial Theory of the Firm," *The Review of Austrian Economics*, 26/3 (September 2013): 277-296 and the discussion of entrepreneurial marketing in Sussie C. Morrish, Morgan P. Miles, and Jonathan H. Deacon,

- "Entrepreneurial Marketing: Acknowledging the Entrepreneur and Customer-Centric Interrelationship," *Journal of Strategic Marketing*, 18/4 (July 2010): 303-316.
18. Jeffrey Dyer, *Collaborative Advantage: Winning through Extended Enterprise Supplier Networks* (New York, NY: Oxford University Press, 2000), pp. 133-139.
 19. Eric Jackson, "Why Tesla Is the Next Webvan," *The Street*, August 18, 2010.
 20. John Reed, "Elon Musk's Ground-Breaking Electric Car," *Financial Times*, July 24, 2009; Tesla Motors, "Tesla Motors Investor Presentation," Palo Alto, CA, 2014, p. 10; Bernie Woodall, Paul Lienert, and Ben Klayman, "GM's Volt: The Ugly Math of Low Sales, High Costs," *Reuters*, September 10, 2012; Nikki Gordon-Bloomfield, "How Much Has Nissan Spent on Electric Cars? \$5.6 Billion...and Counting," *Green Car Reports*, September 7, 2011.
 21. Tesla Motors, "Tesla Motors Investor Presentation," Palo Alto, CA, 2014, pp. 7-8; Tim Higgins, "Akerson Demands GM Innovation to Blunt Tesla Threat," *Bloomberg*, July 17, 2013; Sam Gustin, "'Loser' No More: Tesla Repays \$465 Million U.S. Loan," *Time*, May 23, 2013.
 22. Ries writes, "Contrary to traditional product development, which usually involves a long, thoughtful incubation period and strives for produce perfection, the goal of the MVP is to begin the process of learning, not end it. Unlike a prototype or concept test, an MVP is designed not just to answer product design or technical questions. Its goal is to test fundamental business questions...A minimum viable product (MVP) helps entrepreneurs start the process of learning as quickly as possible. It is not necessarily the smallest product imaginable, though; it is simply the fastest way to get through the Build-Measure-Learn feedback loop with the minimal amount of effort." The \$140 million investments in the Roadster were not the smallest product imaginable, but it helped Tesla get into the auto business and improve its business over time. Ries (2011), op. cit., p. 93.
 23. See Jacobides, MacDuffie, and Tae (2012), op. cit.; Inkpen (2005), op. cit.; Sarasvathy and Dew (2013), op. cit.
 24. See Martin Eberhard, "Lotus Position," *Tesla Motors*, July 25, 2006; Marc Tarpenning, "The 21st Century Electric Car," *Tesla Motors*, July 19, 2006; David Zenlea, "2013 Automobile of the Year: Tesla Model S," *Automobile Magazine*, November 1, 2012; Katie Fehrenbacher, "Tesla CEO Elon Musk: We Should Have Designed an All-Original Car from the Beginning," *Yahoo Finance*, March 14, 2014.
 25. Tesla's recycling of plants is very much in line with Richard Florida's discussion of "Lean and Green: The Move to Environmentally Conscious Manufacturing" or "Ecopreneurship" described by Gerald Gunderson. Richard Florida, "Lean and Green: The Move to Environmentally Conscious Manufacturing," *California Management Review*, 39/1 (Fall 1996): 80-105; Gerald A. Gunderson, "Ecopreneurship" in Samuel O. Idowu, Nicholas Capaldi, Liangrong Zu, and Ananda Das Gupta, eds., *Encyclopedia of Corporate Social Responsibility* (London: Springer, 2013), pp. 909-915. See also Renato Orsato, "Competitive Environmental Strategies: When Does It Pay to Be Green?" *California Management Review*, 48/2 (Winter 2006): 127-143.
 26. S.J. Liebowitz and Stephen Margolis, "Network Externalities: An Uncommon Tragedy," *Journal of Economic Perspectives*, 8/2 (Spring 1994): 133-150.
 27. Katz and Shapiro explain that the hardware-software paradigm applies to many markets including "durable equipment and repair services (the equipment is the hardware, the repair the software" and any network of products that "have little or no value in isolation, but generate value when combined with others." Michael Katz and Carl Shapiro, "Systems Competition and Network Effects," *Journal of Economic Perspectives*, 8/2 (Spring 1994): 93-115. For a discussion of the rise of PayPal, see Edward Peter Stringham, *Private Governance* (Oxford: Oxford University Press, 2015), p. 100.
 28. Jeff Cobb, "Tesla Announces 'World's Best' Service Program," *Hybrid Cars*, April 26, 2013; Deepa Seetharaman, "Tesla Unveils Service Program to Spur Model S Sales," *Reuters Market News*, April 26, 2013.
 29. Elon Musk, "All our patent are belong to you," Palo Alto, CA, Tesla Motors, June 12, 2014. Here, Musk intentionally used the incorrect grammar in reference to a 1990s Japanese video game where a character stated, "All your base are belong to us."
 30. See Bahrami and Evans (2011), op. cit.; Jacobides, MacDuffie, and Tae (2012), op. cit. Jacobides, MacDuffie, and Tae argue that high separability ("low interdependencies, or abundant 'thin crossing places between stages") and high interoperability ("open and commonly used industry standards") allowed the personal computer industry to grow much larger than had it been under the control of one firm.

31. Their motivations may be profit motivated, but may also serve a social goal that Tesla has in its mission, the acceleration of “the advent of sustainable transport.”
32. Jerry Hirsch, “Three Companies, \$4.9 Billion in Government Support,” *Los Angeles Times*, May 30, 2015. Jerry Hirsch, “Elon Musk Defends \$4.9 Billion in Government Money for his Companies,” *Los Angeles Times*, June 1, 2015.
33. Gunderson (2013), op. cit.

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